

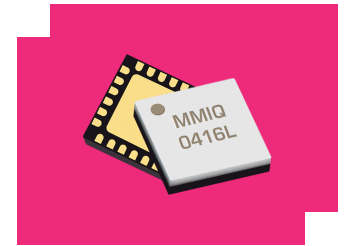
MMIQ-0416LSM-2

Low LO Drive Surface Mount MMIC IQ Mixer

DEVICE OVERVIEW

General Description

The MMIQ-0416LSM is a low LO drive, passive GaAs MMIC IQ. This is an ultra-broadband mixer spanning 4 to 16GHz on the RF and LO ports with an IF from DC to 6 GHz. Up to 40 dB of image rejection is available due to the excellent phase and amplitude balance of its on-chip LO quadrature hybrid. Banded performance is possible at LO drive as low as +4dBm. Both surface QFNs and evaluation boards are available.



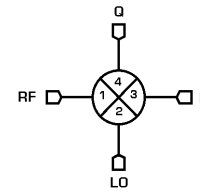
Features

N/A

Applications

- Single Sideband and Image Rejection Mixing
- IQ Modulation / Demodulation
- Vector Amplitude Modulation
- Band Shifting

Functional Block Diagram



Part Ordering Options

| Part Number | Description | Package | Green Status | Product Lifecycle | Export Classification |
|-----------------|---|---------|---------------|-------------------|-----------------------|
| MMIQ-0416LSM-2 | Low LO Drive Surface Mount MMIC IQ Mixer | QFN | REACH RoHS | Released | EAR99 |
| EVAL-MMIQ-0416L | Evaluation Board, Low LO Drive MMIC 4 - 16 GHz IQ Mixer | EVAL | REACH RoHS | Released | EAR99 |

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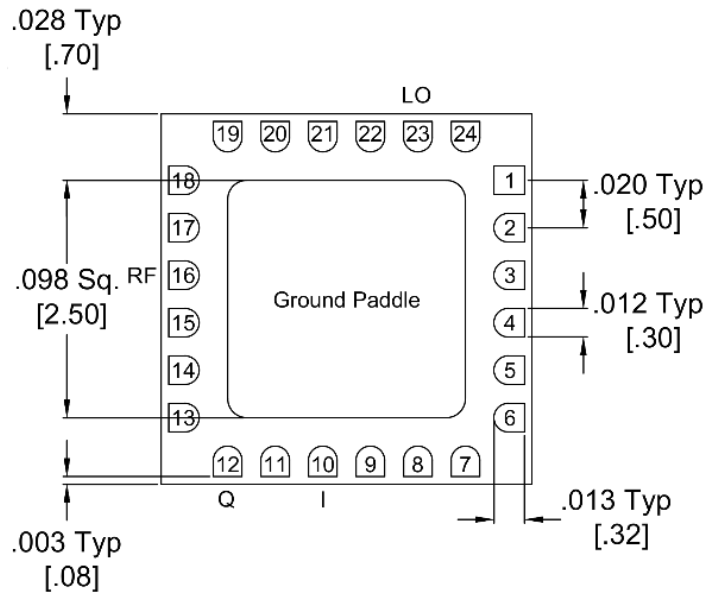
Revision History

| Revision Code | Revision Date | Comment |
|---------------|---------------|---------------------------------|
| - | 2018-12-01 | Datasheet Initial Release |
| A | 2019-08-01 | Changed I/Q Max Current Rating |
| B | 2019-10-01 | Updated Max Power Handling Spec |


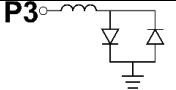
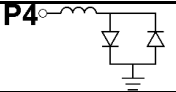
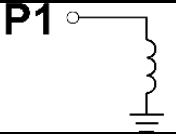
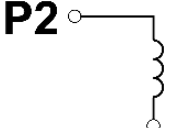
Port Configuration and Functions

Port Diagram

A bottom-up view of the MMIQ-0416L's SM package outline drawing is shown below. The mixer may be operated as either a downconverter or an upconverter. Use of the RF or IF as the input or output port will depend on the application.



Port Functions

| Port | Function | Description | Equivalent Circuit for Package |
|--------|-------------------|--|--|
| GND | Ground | SM package ground path is provided through the ground paddle. | GND  |
| Pin 10 | I Input / Output | Port 3 is diode coupled and AC matched to 50Ω over the specified I port frequency range. | P3  |
| Pin 12 | Q Input / Output | Port 4 is diode coupled and AC matched to 50Ω over the specified Q port frequency range. | P4  |
| Pin 16 | RF Input / Output | Port 1 is DC short and AC matched to 50Ω over the specified RF frequency range. | P1  |
| Pin 23 | LO Input | Port 2 is DC open and AC matched to 50Ω over the specified LO frequency range. | P2  |

Specifications

Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

| Parameter | Maximum Rating | Unit |
|-------------------------------|----------------|------|
| Maximum Operating Temperature | 100 | °C |
| Maximum Storage Temperature | 125 | °C |
| Minimum Operating Temperature | -55 | °C |
| Minimum Storage Temperature | -65 | °C |
| Pin 10 DC Current | 30 | mA |
| Pin 12 DC Current | 30 | mA |
| Power Handling, at any Port | 26 | dBm |

Package Information

| Parameter | Details | Rating |
|----------------------------|--------------------|--------------|
| ESD | 250 to < 500 Volts | HBM Class 1A |
| Dimensions | - | 4 x 4 mm |
| Moisture Sensitivity Level | - | MSL 1 |

Recommended Operating Conditions

The Recommended Operating Conditions indicate the limits, inside which the device should be operated, to guarantee the performance given in Electrical Specifications. Operating outside these limits may not necessarily cause damage to the device, but the performance may degrade outside the limits of the electrical specifications. For limits, above which damage may occur, see Absolute Maximum Ratings.

| Parameter | Min | Nominal | Max | Unit |
|---------------------|-----|---------|-----|------|
| RF/IF Input Power | - | - | 7.3 | dBm |
| LO Input Power | 7 | 13 | 16 | dBm |
| Ambient Temperature | -55 | 25 | 100 | °C |

Sequencing Requirements

There is no requirement to apply power to the ports in a specific order. However, it is recommended to provide a 50Ω termination to each port before applying power. This is a passive diode mixer that requires no DC bias.

Electrical Specifications

The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +13dBm sine wave LO input. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C. All bare die are 100% DC tested and visually inspected.

| Parameter | Test Conditions | Minimum Frequency (GHz) | Maximum Frequency (GHz) | Min | Typ | Max | Unit |
|--------------------------------------|--|-------------------------|-------------------------|-----|-----|-----|------|
| Amplitude Balance ¹ | - | - | - | - | 0.5 | - | dB |
| Conversion Loss ² | RF/LO = 4 - 16 GHz I = 0.2 - 6 GHz | 4 | 16 | - | 14 | - | dB |
| Conversion Loss ³ | RF/LO = 4 - 16 GHz I = DC - 0.2 GHz | 4 | 16 | - | 12 | 15 | dB |
| Conversion Loss ⁴ | RF/LO = 4 - 16 GHz Q = 0.2 - 6 GHz | 4 | 16 | - | 14 | - | dB |
| Conversion Loss ⁵ | RF/LO = 4 - 16 GHz Q = DC - 0.2 GHz | 4 | 16 | - | 12 | 15 | dB |
| IF Frequency Range | - | - | - | 0 | - | 6 | GHz |
| Image Rejection ⁶ | RF/LO = 4 - 16 GHz I+Q = DC - 0.2 GHz | 4 | 16 | - | 31 | - | dBc |
| Input 1 dB Gain Compression Point, I | - | - | - | - | 7.3 | - | dBm |
| Input 1 dB Gain Compression Point, Q | - | - | - | - | 7.3 | - | dBm |
| Input IP3 ⁷ | RF/LO = 4 - 6 GHz I = DC - 0.2 GHz | 4 | 6 | - | 16 | - | dBm |
| Isolation, LO to IF | IF/LO = 4 - 16 GHz | 4 | 16 | - | 39 | - | dB |
| Isolation, LO to RF | RF/LO = 4 - 16 GHz | 4 | 16 | - | 51 | - | dB |
| Isolation, RF to IF | RF/IF = 4 - 16 GHz | 4 | 16 | - | 31 | - | dB |
| LO Frequency Range | - | - | - | 4 | - | 16 | GHz |
| Noise Figure ⁸ | RF/LO = 4 - 16 GHz I = DC - 0.2 GHz | 4 | 16 | - | 12 | - | dB |
| Noise Figure ⁹ | RF/LO = 4 - 16 GHz Q = DC - 0.2 GHz | 4 | 16 | - | 12 | - | dB |
| Phase Balance | - | - | - | - | 2 | - | ° |
| Q (Port 4) Frequency Range | - | - | - | 0 | - | 6 | GHz |
| RF Frequency Range | - | - | - | 4 | - | 16 | GHz |

[1] Amplitude and phase balance measured in a down conversion.

[2][3][4][5] Measured as an I/Q down converter (i.e., I and Q powers are not combined)

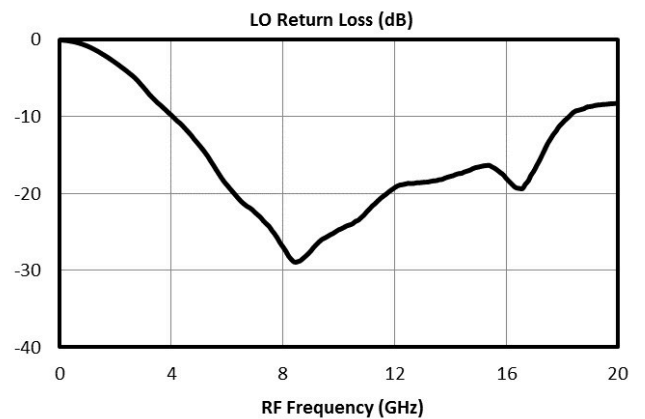
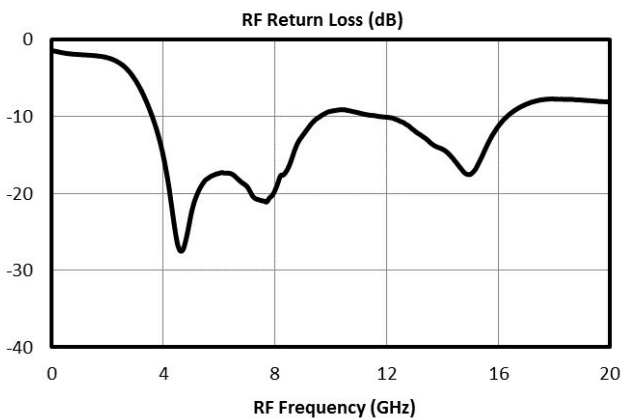
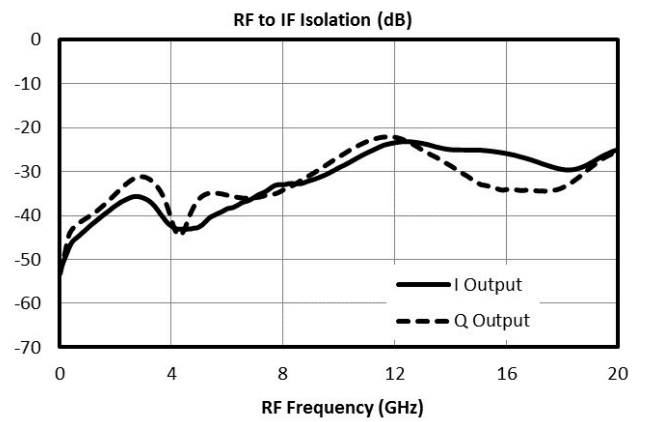
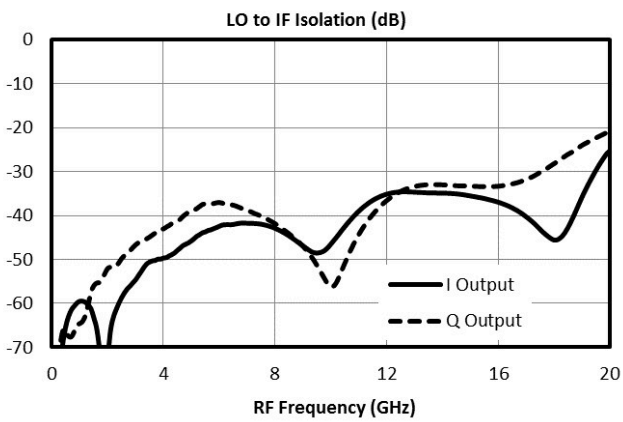
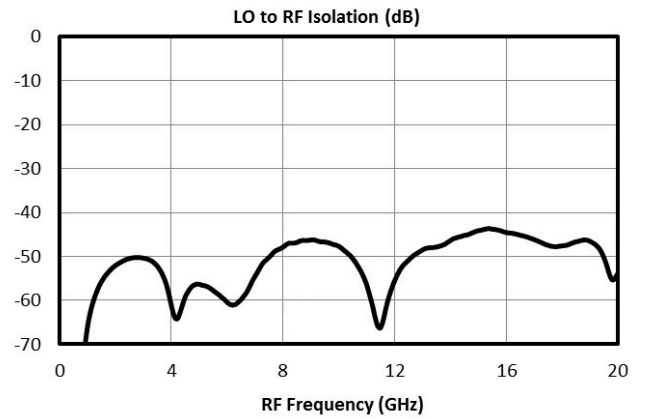
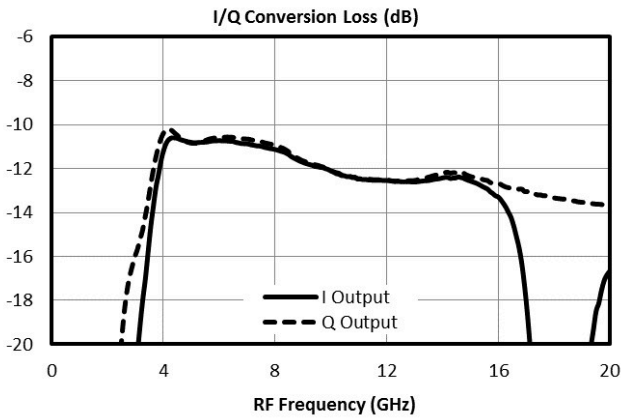
[6] Image Rejection and Single sideband performance plots are defined by the upper sideband (USB) or lower sideband (LSB) with respect to the LO signal. Plots are defined by which sideband is selected by the external IF quadrature hybrid.

[7] Typical IIP3 is measured with I and Q ports combined with an external quadrature hybrid coupler in a down conversion.

[8][9] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

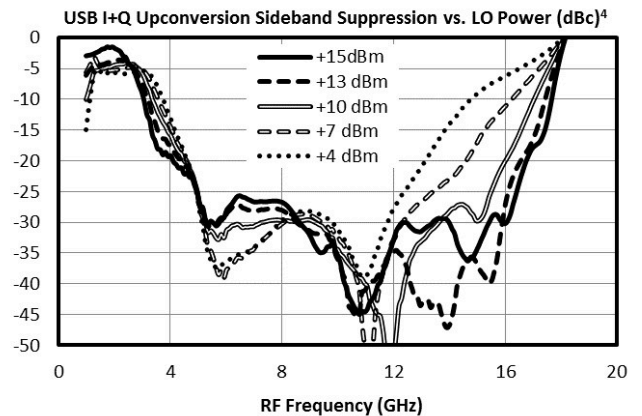
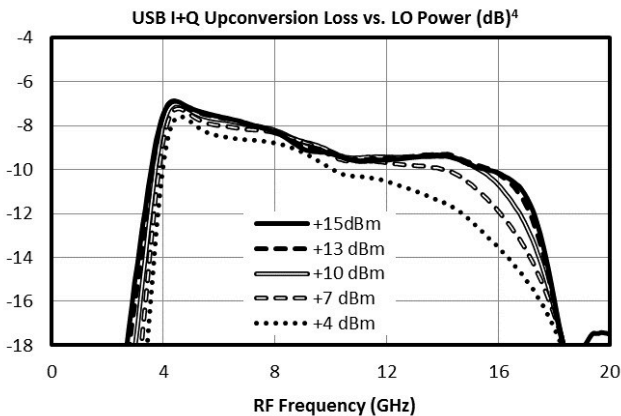
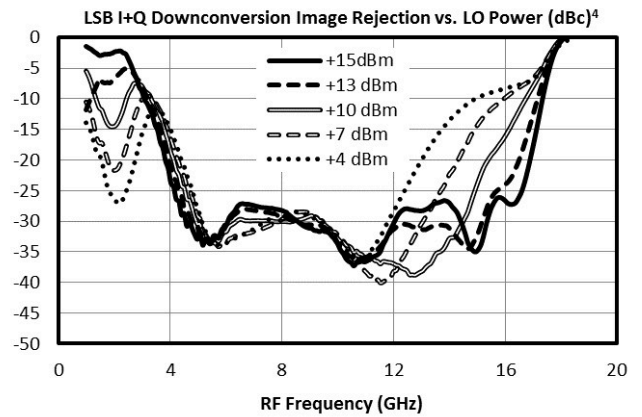
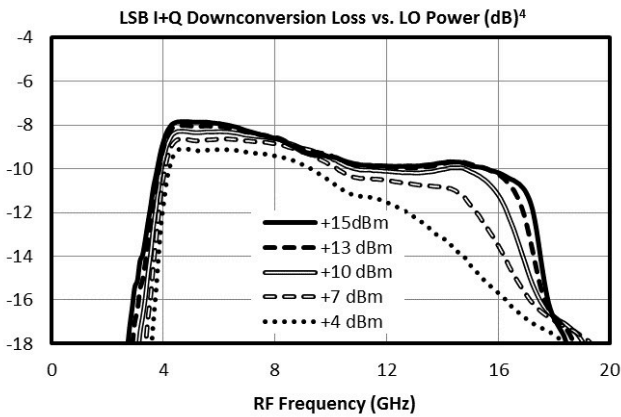
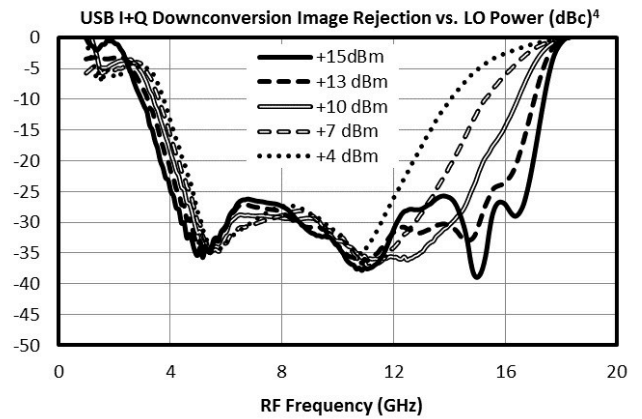
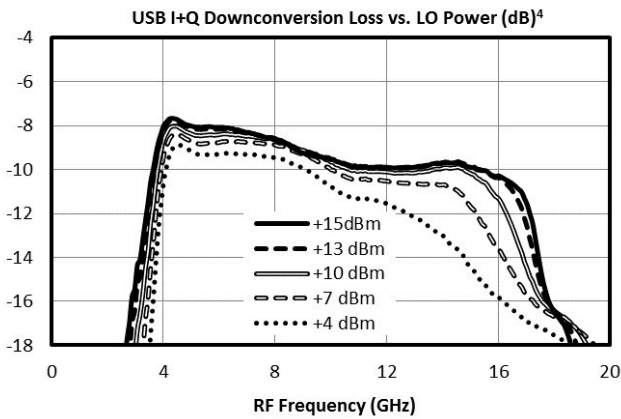
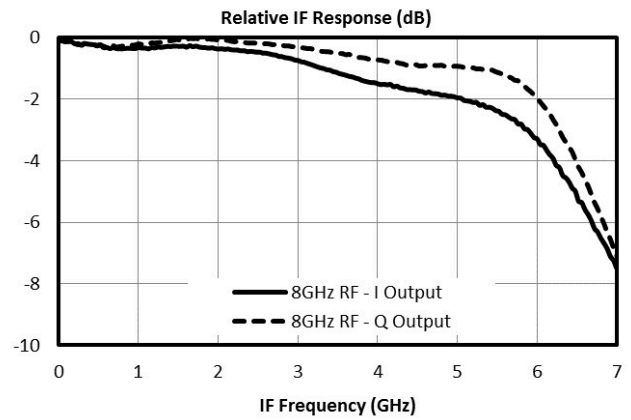
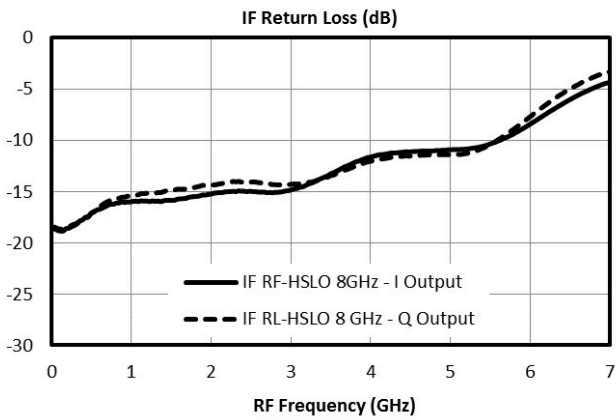
Typical Performance Plots

I output means that the IF output signal is measured at the I port of the mixer and the Q port is loaded. Q output means the IF output signal is measured at the Q port of the mixer while the I port is loaded.



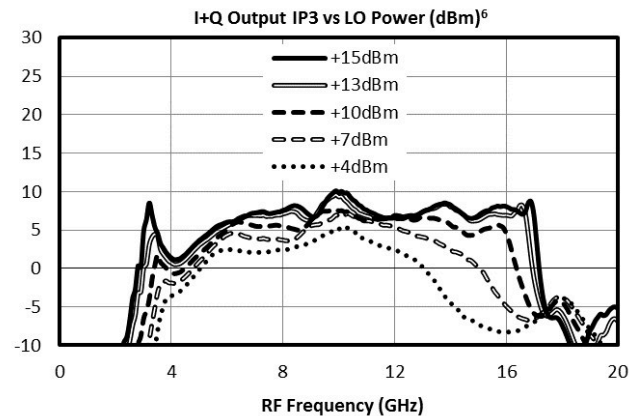
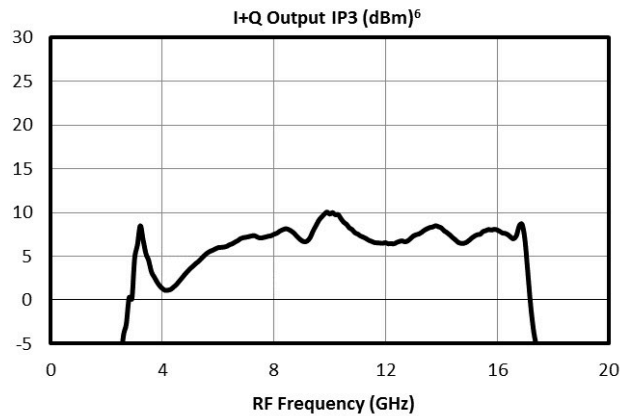
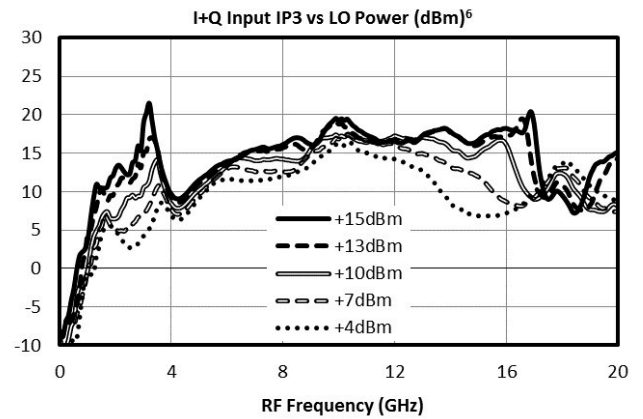
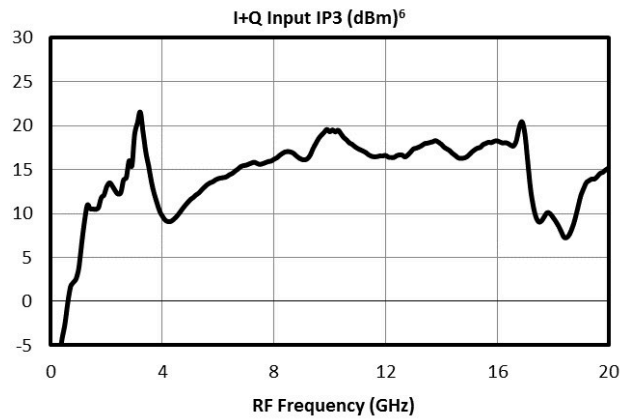
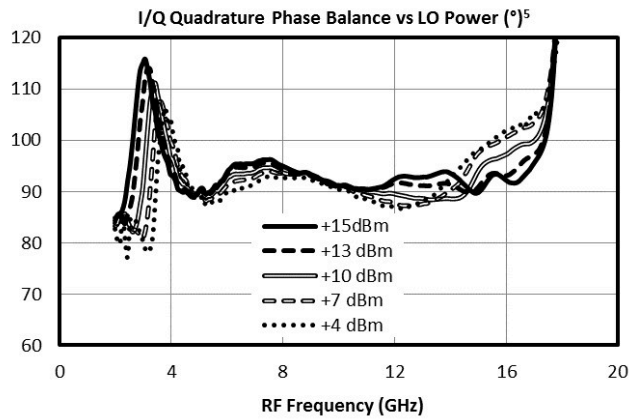
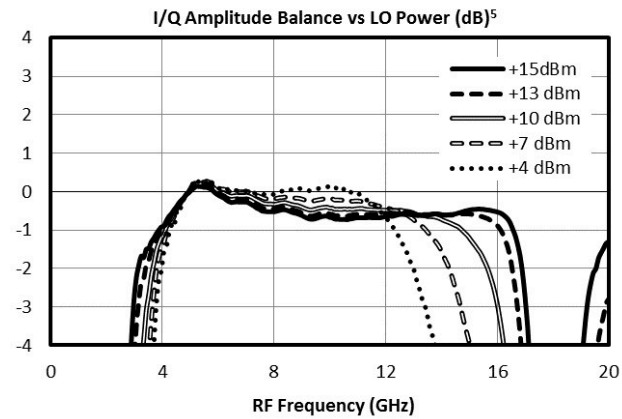
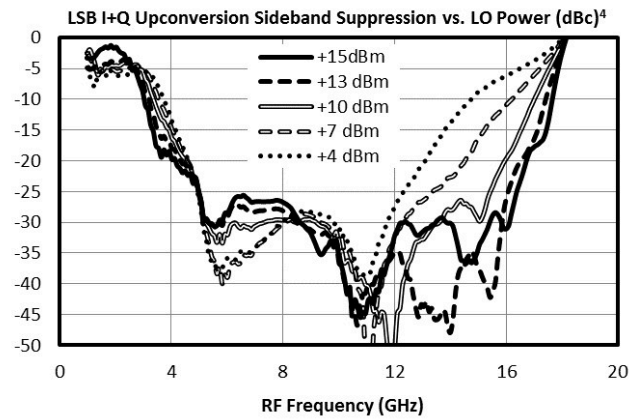
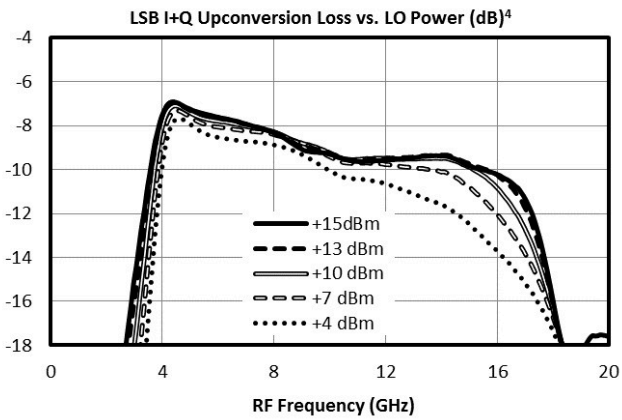
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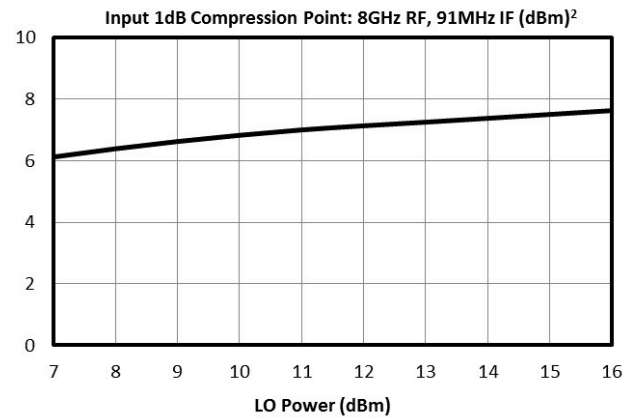
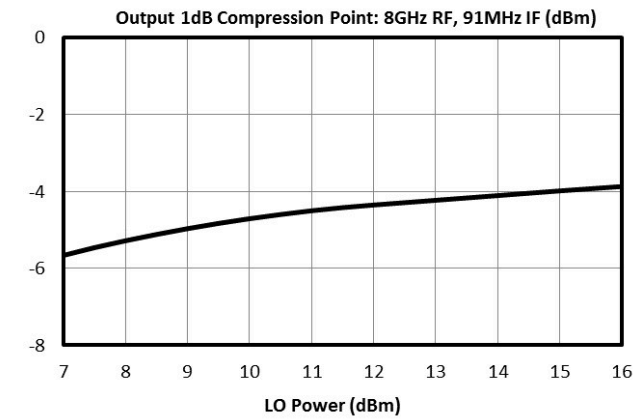
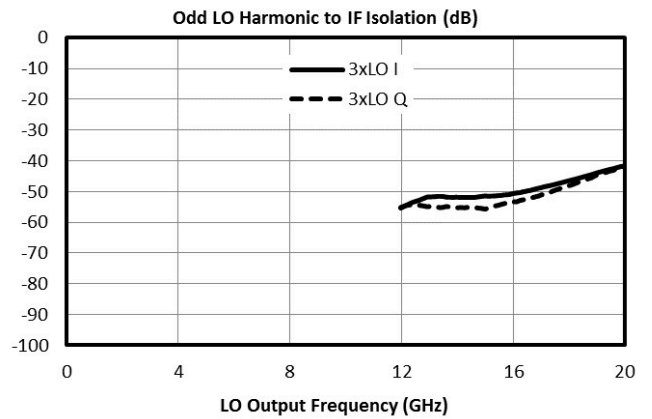
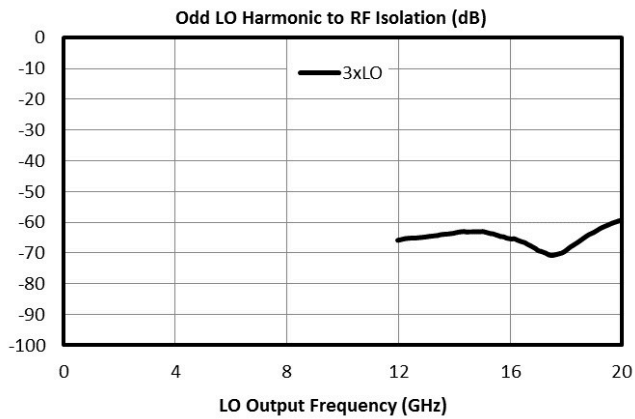
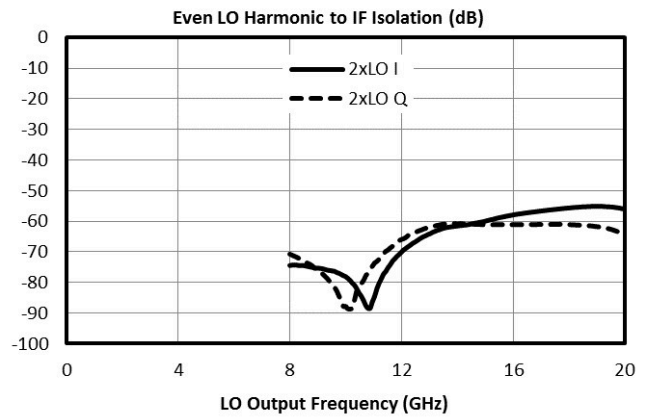
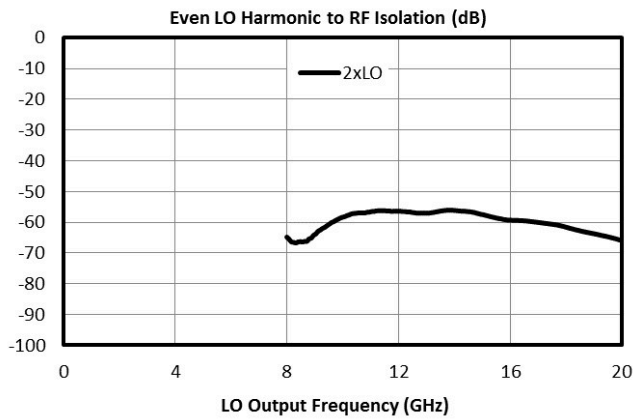
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Spur Table

Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies ($\pm m \cdot LO \pm n \cdot RF$) within the RF/LO bands, to create a spurious output within the IF band. The mixer is swept across the full spurious band and the mean is calculated. The numbers shown in the table below are for a -10 dBm RF input. Spurious suppression is scaled for different RF power levels by (n-1), where “n” is the RF spur order. For example, the 2RF x 2LO spur is 71 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 81 dBc. Data is shown for the frequency plan in Typical Performance.

Typical Down-conversion spurious suppression (dBc): I Port (Q Port)

| -10 dBm RF Input | 0xLO | 1xLO | 2xLO | 3xLO | 4xLO | 5xLO |
|------------------|---------|-----------|-----------|-----------|-----------|-----------|
| 0xRF | - | 19 (18) | 48 (47) | 30 (33) | N/A | N/A |
| 1xRF | 30 (27) | Reference | 36 (37) | 15 (13) | 58 (42) | N/A |
| 2xRF | 81 (85) | 52 (52) | 71 (71) | 57 (56) | 78 (78) | 60 (65) |
| 3xRF | 76 (77) | 54 (55) | 85 (82) | 65 (66) | 90 (95) | 68 (68) |
| 4xRF | N/A | 87 (98) | 106 (111) | 103 (104) | 116 (120) | 103 (105) |
| 5xRF | N/A | N/A | 112 (113) | 109 (110) | 131 (129) | 117 (117) |

Measured as I/Q mixer (not IR/SSB mixer). SSB/IR mixers experience additional spurious suppressions.

Typical Spurious Performance: Up-Conversion

Typical spurious data is taken by mixing an input within the IF band, with LO frequencies ($\pm m \cdot LO \pm n \cdot IF$), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band and the mean is calculated. The numbers shown in the table below are for a -10 dBm IF input. Spurious suppression is scaled for different IF input power levels by (n-1), where “n” is the IF spur order. For example, the 2IFx1LO spur is typically 68 dBc for a -10 dBm input with a sine-wave LO, so a -20 dBm IF input creates a spur that is (2-1) x (-10 dB) lower, or 78 dBc. Data is shown for the frequency plan in Typical Performance.

Typical Up-conversion spurious suppression (dBc): I Port (Q Port)

| -10 dBm RF Input | 0xLO | 1xLO | 2xLO | 3xLO | 4xLO | 5xLO |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| 0xIF | - | 30 (30) | 37 (37) | 42 (42) | N/A | N/A |
| 1xIF | 31 (25) | Reference | 42 (34) | 20 (16) | 42 (52) | N/A |
| 2xIF | 55 (55) | 68 (72) | 48 (47) | 71 (67) | 54 (51) | 78 (70) |
| 3xIF | 71 (78) | 53 (55) | 79 (75) | 48 (49) | 80 (83) | 66 (64) |
| 4xIF | 95 (95) | 114 (118) | 94 (93) | 116 (112) | 93 (90) | 122 (125) |
| 5xIF | 119 (124) | 102 (104) | 124 (120) | 97 (97) | 124 (124) | 101 (100) |

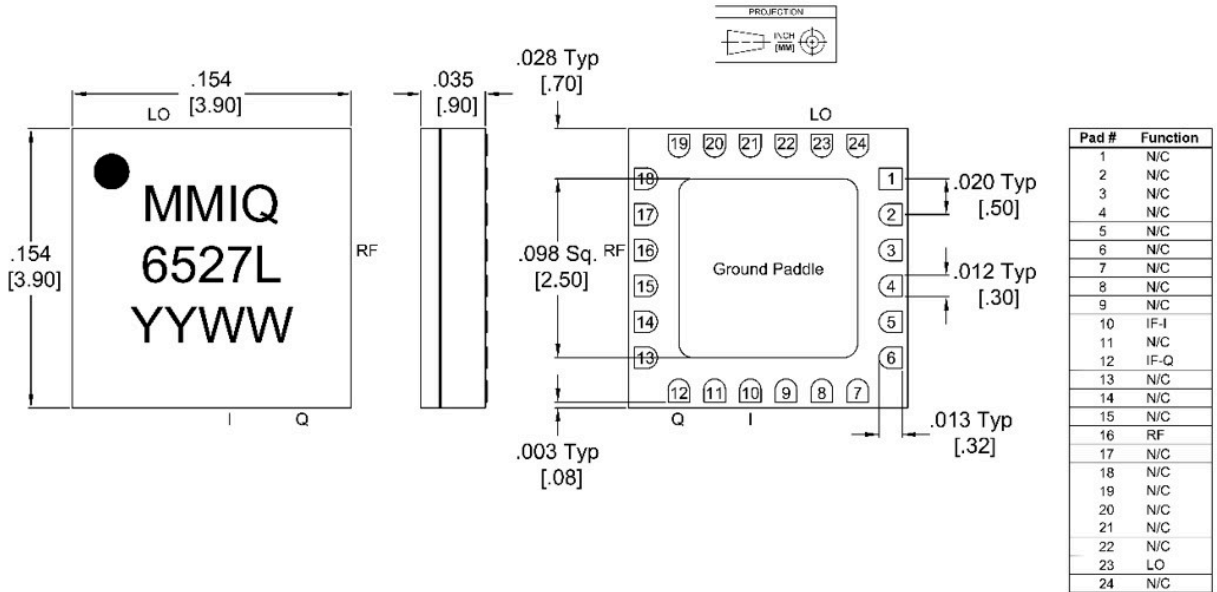
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Mechanical Data

Outline Drawing

Download : [Outline 2D Drawing](#) | [Outline 3D Drawing](#) | [Outline 3D STP](#)



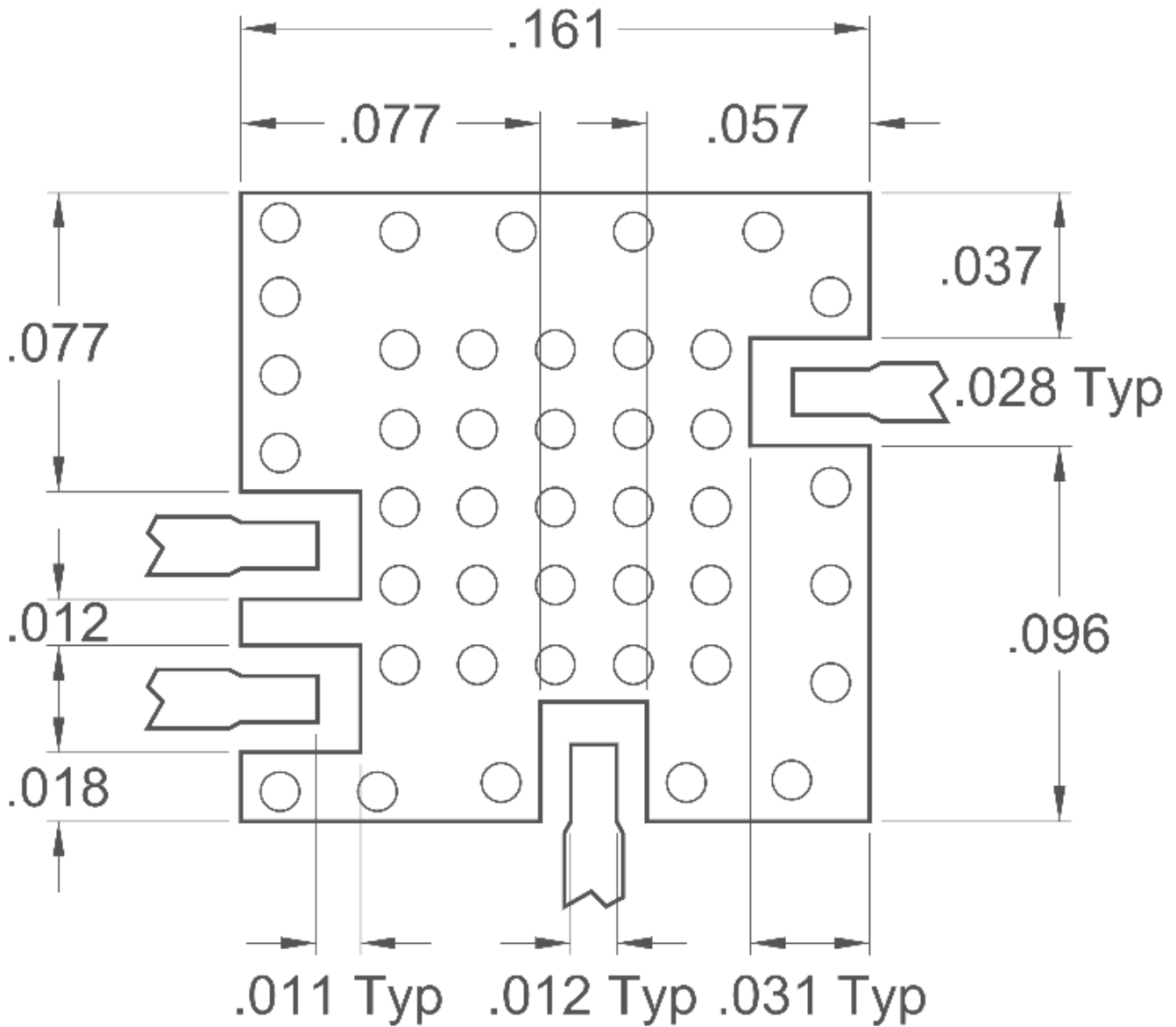
- Substrate material is ceramic.
- I/O Leads and Ground Paddle plating is (from base to finish):

| | | |
|-----|-------------|------------|
| Ni: | 8.89um MAX | 1.27um MIN |
| Pd: | 0.17um MAX | 0.07um MIN |
| Au | 0.254um MAX | 0.03um MIN |
- All unconnected pads should be connected to PCB RF ground.

1.27um MIN
0.07um MIN
0.03um MIN

Footprint Image

Download: [Footprint Drawing](#)



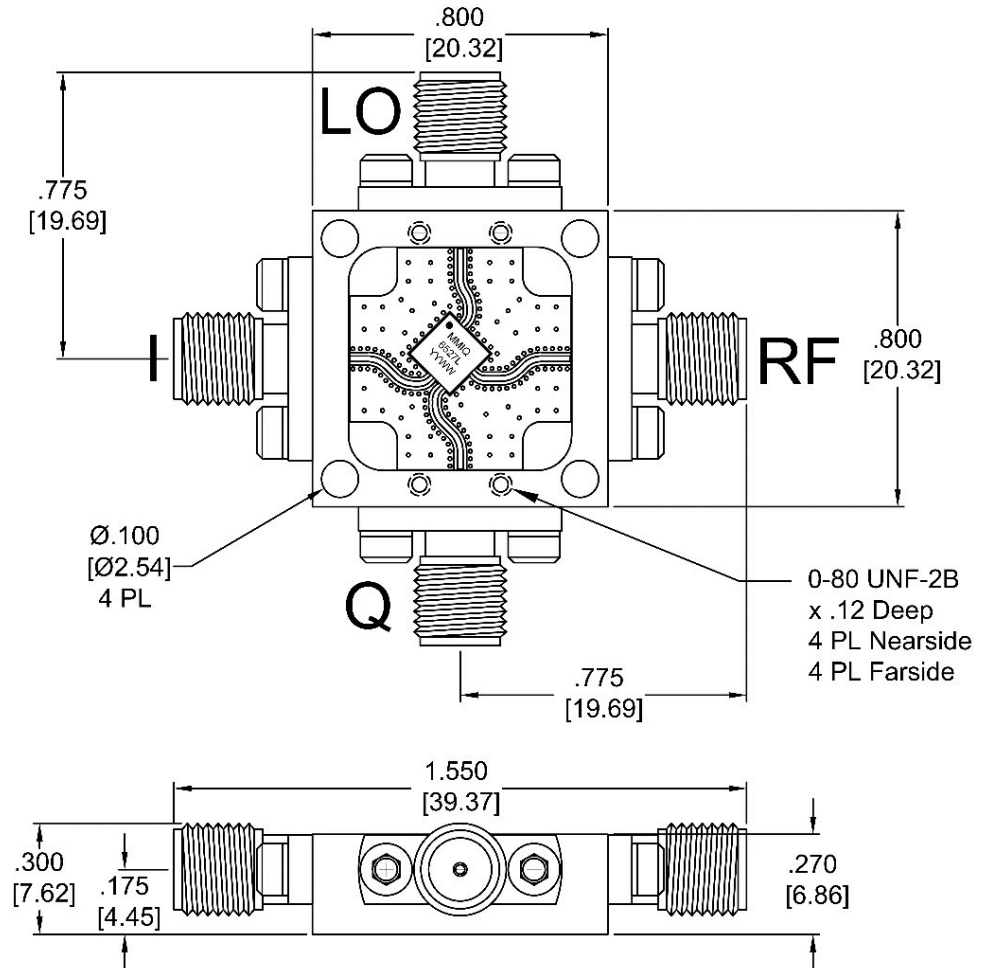
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Evaluation Board - Outline Drawing

| Port | Connector Type |
|------|----------------|
| LO | SMA Female |
| RF | SMA Female |
| I/Q | SMA Female |

Note: Eval Connectors are not removable.



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